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ABSTRACT

This booklet is intended to help mainstreamed mentally retarded, emotionally disturbed, or learning disabled high school students acquire a basic understanding of the responsibilities and working conditions of programmers and to practice basic math skills necessary in the occupation. The first section provides a brief introduction to the occupation by focusing upon those job tasks of a programmer with which the student is likely to be familiar. The next two sections deal with the work environment of the typical programmer and the training, education, and experience needed for the occupation. Exercises addressing basic math skills used by programmers are provided. Various suggestions are listed for students interested in further exploring the occupation of programmer. A glossary and answer sheet conclude the booklet. (KC)

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MATH on the job

Programmer

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MATH ON THE JOB:

PROGRAMMER

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MATH on the job

Programmer

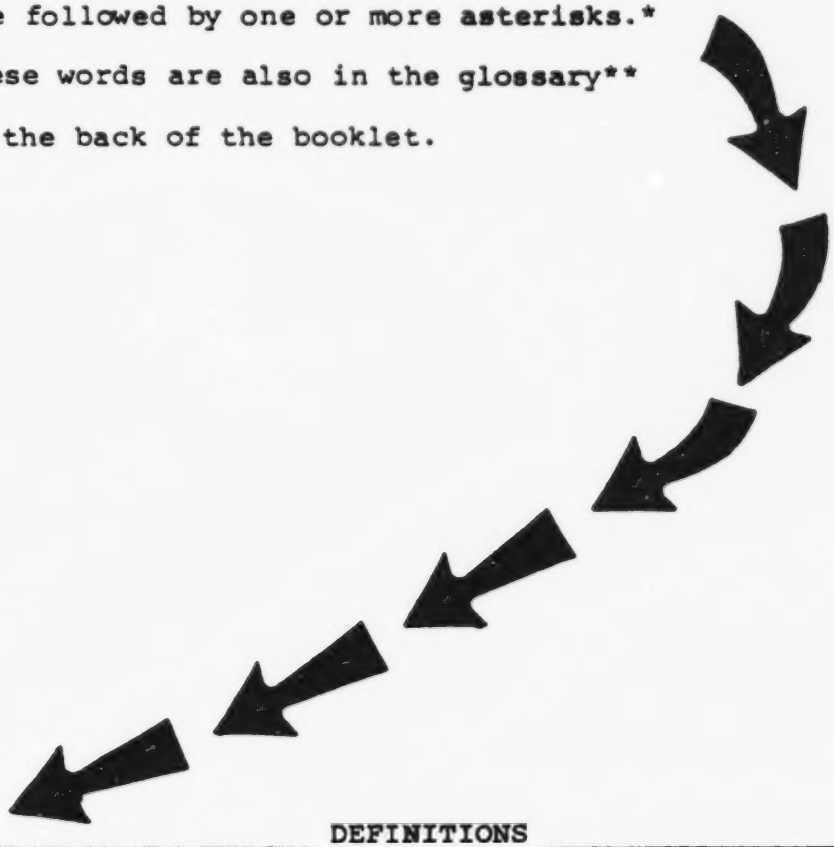
In this booklet, you can--

- find out what a programmer does
- see how a programmer uses math
- get a chance to use math as a programmer
- find out the types of things a programmer needs to know
- find out what courses, training, and experience you need to become a programmer

SPECIAL WORDS USED IN THIS BOOKLET

Workers in many jobs use special words or special meanings for words. Learning these words helps you to learn about a job.

You will find some of these special words in this booklet. When these words, and some hard words, are used for the first time, they are followed by one or more **asterisks.*** These words are also in the **glossary**** at the back of the booklet.



DEFINITIONS

*An asterisk (*) is a symbol that tells you to look at the bottom of the page for the meaning, or definition, of the word.

**A glossary is a list of words with their meanings.

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WHAT DOES A PROGRAMMER DO?

The main task of a programmer is to write instructions that control the work of a computer. Since a computer is a machine and cannot think, a programmer must write detailed, step-by-step directions telling the computer what to do. How does a programmer do this? A programmer--

- finds out what tasks or problems the computer needs to do
- figures out how the computer can be used to do the tasks
- writes detailed instructions, called a program, for the computer
- puts the instructions in the step-by-step order
- types the instructions into the computer
- finds and corrects any mistakes in the instructions

Programmers use math in their work every day. As a programmer, you--

- add, subtract, multiply, and divide
- read scales
- read tables, charts, graphs, and drawings
- measure time
- calculate percentages
- calculate averages

A programmer uses math to read charts.

EXAMPLE

As a programmer, you will need to read and understand charts. Sometimes charts will tell you how to convert English words into computer language words. Sometimes charts will tell you how to convert from one number system to another. The chart below tells how to convert letters into code numbers that a computer can understand. Once you find the letter you want on the chart, the column on the left tells you the first one or two digits in the code. Then you use the number at the head of the column as the last digit of the code. For example, the code number for R is 82.

Left Digit(s) \ Right Digit	0	1	2	3	4	5	6	7	8	9
3				!	"	#	$	%	&	'
4	(	)	*	+	,	-	.	/	0	1
5	2	3	4	5	6	7	8	9	:	;
6	<	=	>	?	@	A	B	C	D	E
7	F	G	H	I	J	K	L	M	N	O
8	P	Q	R	S	T	U	V	W	X	Y
9	Z	[	1/8	]	^	_	`	a	b	c
10	d	e	f	g	h	i	j	k	l	m
11	n	o	p	q	r	s	t	u	v	w
12	x	y	z	{	|	}	~			

Codes 00 to 31 and 127 (decimal) represent special control characters that are not printable.

NOW YOU TRY IT

Practice Exercise A

For 1-6, use the chart in the example to find the code number for the letter or symbol shown.

1. F ___?___ 2. q ___?___ 3. E ___?___

4. v ___?___ 5. = ___?___ 6. d ___?___

For 7-12, use the chart in the example to find the letter or symbol represented by the code number given.

7. 114 ___?___ 8. 33 ___?___ 9. 87 ___?___

10. 61 ___?___ 11. 122 ___?___ 12. 93 ___?___

A programmer uses math to estimate time.

EXAMPLE

Programmers sometimes need to estimate the time it will take to write a computer program. If a programmer can write 20 lines of the program every hour, how many lines could a programmer write in 8 hours, or one day?

20 lines x 8 hours = 160 lines

The programmer could write 160 lines in one day.

NOW YOU TRY IT

Practice Exercise B

13. A programmer writes 25 lines of computer programming every hour. How long is the program that was written in 4 hours?

14. A program took 30 hours to write. The programmer wrote 45 lines per hour. How many lines are in the program?

15. A programmer has 12 1/2 hours to work on a program. The programmer can write 23 lines per hour. What is the greatest number of lines that the program can be?

16. A programmer has two days (16 hours) to write a program. The programmer can write between 18 and 26 lines per hour. What is the shortest program that can be written? What is the longest program that can be written?

17. A 300-line program must be written. The programmer can write 15 lines per hour. How long will it take to write the whole program?

A programmer uses math to convert numbers.

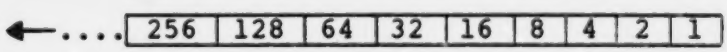
EXAMPLE

The numbers we normally use are made up of the digits 0 to 9. This is called the decimal system. Computers use the binary system instead. All numbers in the binary system have two digits, 0 and 1. A programmer must know how to convert numbers from one system to another.

To convert a decimal number to the binary system, divide it by 2 until you reach 0. Keep track of the remainders. At the end, read the remainders backwards for the answer. To find 22 in the binary system:

2 /22			
2 /11	Remainder	0	
2 / 5		1	
2 / 2		1	22 is
2 / 1		0	equal to
0		1	10110

To convert a binary to a decimal, look for the 1's in the number. Each one represents a power of 2, depending on its place in the number:



First find the corresponding "powers of 2" for each "1" in the binary number:

1 0 1 1 0 = 2
1 0 1 1 0 = 4
1 0 1 1 0 = 16

Then add the "powers of 2" to find the decimal number:
(from right to left): 2 + 4 + 16 = 22
So 10110 is equal to 22.

NOW YOU TRY IT

Practice Exercise C

Convert the numbers on the left to decimal numbers and the numbers on the right to binary numbers.

18. 111	?	19. 7	?
20. 11010	?	21. 16	?
22. 10100	?	23. 3	?
24. 1001	?	25. 25	?
26. 101101	?	27. 38	?

A programmer uses math to check that programs work right.

EXAMPLE

Some computer programs figure out the average of a list of numbers. The numbers to be averaged are the **input*** to the program. The average given by the computer is the **output****. The programmer checks that new programs work right by figuring the answer and comparing it to the output. Find the average of 24, 12, and 13:

$$\frac{24 + 12 + 13}{3} = 49/3 = 16\ 1/3$$

The output should be 16 1/3.

NOW YOU TRY IT

Practice Exercise D

28. The program figures out the average, and your input is 3;5;6;3;9;4. What should be the output?

29. Your input to the averaging program is 235;212; 178;415;201;289. What should be the output?

30. You run the averaging program using 12;13;18;12; 14;15;12 as the input. What should be the output?

31. You input 12.5; 14.7; 18.3; 10; to the averaging program. What should be the output?

32. You run the averaging program using .11; 1.9; .9; .75; .894 as your input. What should be the output?

DEFINITIONS

*Input is information, or data, provided for the computer to use when it performs the calculations in the program.

**Output is information which the program figures out and the computer sends back.

WHERE DOES A PROGRAMMER WORK?

As a programmer, you may work in many places. You may work for--

- o insurance companies
- o banks
- o manufacturing plants
- o hospitals
- o schools
- o government agencies
- o research firms

Where would you like to work?

You will work with many people. You will work with--

- o customers
- o computer operators
- o other programmers
- o **systems analysts***

DEFINITION

*__Systems analysts__ are people who plan, schedule, and coordinate all the activities required to process data.

As a programmer, you will work with many different machines. You will work with--

- **terminals** that show data on a screen
- **printers** that produce a paper copy of the data
- **scanners** that electronically read the data from cards or paper
- **keypunch machines** that cut holes in punch cards

There are two different types of programmers.

- **Systems programmers** usually are employed by the companies that manufacture computers. They write programs that make it easier to operate the machines, such as the programs that operate printers.

- **Applications programmers** usually are employed by companies that use computers. They write programs that make the machine do specific jobs, such as programs for calculating payroll amounts.

IF YOU ARE INTERESTED IN

THE WORK OF A PROGRAMMER

AND WOULD LIKE TO KNOW MORE,

READ ON

WHAT TRAINING, EDUCATION, AND EXPERIENCE DO YOU NEED TO BECOME A PROGRAMMER?

What do you think? Would you like to be a programmer? If you would, there are some things you should know.

You should know--

- how computers work
- **computer languages***
- how to solve problems using a step-by-step approach
- how to do mathematics

While you are in high school, you should take courses in mathematics and science. You can get additional training to be a programmer at a junior or community college. However, many employers require programmers to have a college degree in computer science or mathematics. Some employers will accept college degrees in business, engineering, or physics.

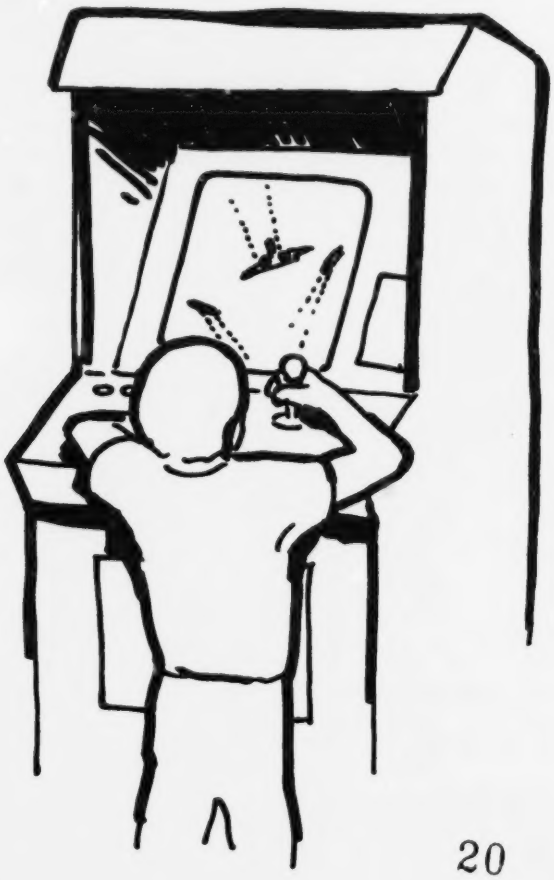
DEFINITION

*Computer languages are special languages made up of code words. The code words tell the computer what steps to do.

Once you get a job as a programmer, your employer probably will send you to a computer school for a few weeks. The computer school usually is run by the manufacturer of the computer. At the school, you will learn all about the machine and what it can do.

On the job, you will work with experienced programmers who will teach you about programming. It can take a year or more of working on the job before you learn all you need to know about programming.

Taking every chance to learn new skills and tasks will help you do a better job. Good math skills will also help you do the work of a programmer.



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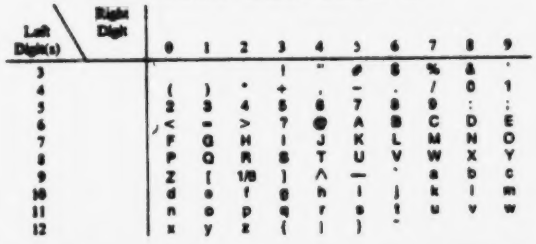
DO YOU WANT TO DO MORE PROGRAMMER'S MATH?

Practice Exercise E



Left Digit(s) \ Right Digit	0	1	2	3	4	5	6	7	8	9
3				!	"	#	$	%	&	'
4	(	)	*	+	,	-	.	/	0	1
5	2	3	4	5	6	7	8	9	:	;
6	<	=	>	?	@	A	B	C	D	E
7	F	G	H	I	J	K	L	M	N	O
8	P	Q	R	S	T	U	V	W	X	Y
9	Z	[	\	]	^	_	`	a	b	c
10	d	e	f	g	h	i	j	k	l	m
11	n	o	p	q	r	s	t	u	v	w
12	x	y	z	{	|	}	~			

Codes 00 to 31 and 127 (decimal) represent special control characters that are not printable.

Using the chart above, find the code number for the following letters or symbols.

33.	@	?	34.	:	?	35.	T	?
36.	W	?	37.	e	?	38.	+	?
39.	!	?	40.	)	?	41.	g	?

Find the letter or symbol for each of these code numbers by using the chart above.

42.	33	?	43.	57	?	44.	66	?
45.	48	?	46.	39	?	47.	125	?
48.	70	?	49.	81	?	50.	127	?

Practice Exercise F

51. A 528-line program must be written. The programmer can write 22 lines per hour. How many days will it take to write the program?

52. A very hard 1000-line program needs to be written. Two programmers will be writing 15 lines each per hour. How many hours will it take them to finish?

53. A huge, 5000-line program must be written. Four programmers will be writing 25 lines each per hour. How many hours will it take them to finish?

54. A programmer can write between 160 and 215 lines per day. What is the shortest program which could be written in six days? What is the longest?

55. Three programmers are working on a 2000-line program. If each programmer writes 15 lines per hour, how many days will it take them to finish?

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Practice Exercise G

Convert the numbers on the left to decimal numbers and the numbers on the right to binary numbers.

56.	101110	?	57.	65	?
58.	1111	?	59.	49	?
60.	1101101	?	61.	101	?
62.	11100	?	63.	53	?
64.	1010100	?	65.	99	?
66.	110111	?	67.	2	?
68.	11101	?	69.	18	?
70.	1101	?	71.	27	?
72.	1010000	?	73.	257	?
74.	1100011	?	75.	81	?

Practice Exercise H

76. A program converts decimals into fractions. You input .75. What should be the output?

77. You input .116 into the program which rounds a decimal to two places. What should be your output?

78. You input 9.25 into a program which takes a number and triples it. What should be your output?

79. A program takes the number input, doubles it and then converts it to a percentage of 100. You input 35. What should be the output?

80. A program takes the input number, calculates a 5.5% sales tax amount and then adds the sales tax to the original number to output the total cost. You input $24.95. What should be the output?

DO YOU WANT TO EXPLORE SOME MORE?

1. Arrange a visit to a business, school, or other organization that owns and uses a computer. Ask to tour the computer room. Look at the different machines. Find out what the machines do.

2. Look in the newspaper for any help wanted ads for programmers. What training, education, and experience do the ads ask for? How much do the jobs pay?

3. Ask your teacher or guidance counselor to help you find a computer to use. Read the instructions on how to use the computer. Use the programs that come with the machine. Do you like working with computers?

4. Are you interested in other jobs where you could work with computers?

   - **Console operators** or **computer operators** start the computer, give the computer programmed instructions, and make sure the machines operate correctly.

   - **Keypunch operators** prepare data to be put into the computer.

   - **Coding clerks** assist programmers in preparing flow charts and in writing the coded instructions.

   - **Converter operators** take the data the machine puts out and explains it in words and numbers.

   You can do some of these jobs without all the math skills listed in this booklet. But you can do a better job if you have math skills. You may get a chance to move up to a better job if you can show that you can do your job well and that you can do the math needed on the job.

GLOSSARY

Asterisk (*): a mark that tells you to look at the bottom of the page for the meaning, or definition, of the word.

Computer languages: special languages made up of code words. The code words tell the computer what steps to do.

Glossary: a list of words with their meanings.

Input: information, or data, provided for the computer to use when it performs the calculations in the program.

Output: information which the program figures out and the computer sends back.

Systems analysts: people who plan, schedule, and coordinate all the activities required to process data.

ANSWER SHEET

Practice Exercise A

1. 70
2. 113
3. 69
4. 118
5. 61
6. 100
7. r
8. !
9. W
10. =
11. z
12.]

Practice Exercise B

13. 100 lines
14. 1,350 lines
15. 287 lines
16. 288 lines; 416 lines
17. 20 hours

Practice Exercise C

18. 7
19. 111
20. 26
21. 10000
22. 20
23. 11
24. 9
25. 11001
26. 45
27. 100110

Practice Exercise D

28. 5
29. 255
30. 13 5/7
31. 13.875
32. .9108

Practice Exercise E

33. 64
34. 58
35. 84
36. 87
37. 101
38. 43

Practice Exercise E (cont.)

39. 33
40. 41
41. 103
42. !
43. 9
44. B
45. 0
46. '
47.
48. F
49. Q
50. not printable

Practice Exercise F

51. 3 days
52. 33-1/3 hours
53. 50 hours; 6-1/4 days
54. 960 lines; 1,290 lines
55. 5-5/9 days

Practice Exercise G

56. 46
57. 1000001
58. 15
59. 110001
60. 109
61. 1100101
62. 28
63. 110101
64. 84
65. 1100011
66. 55
67. 10
68. 29
69. 10010
70. 13
71. 11011
72. 80
73. 100000001
74. 99
75. 1010001

Practice Exercise H

76. 3/4
77. .12
78. 27.75
79. 70%
80. $26.32